Maintaining Diesel Engines for Emissions Control

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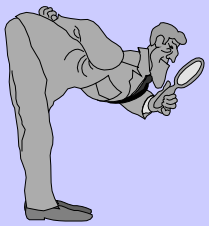
Auditing Engine Maintenance



Auditing Engine Maintenance

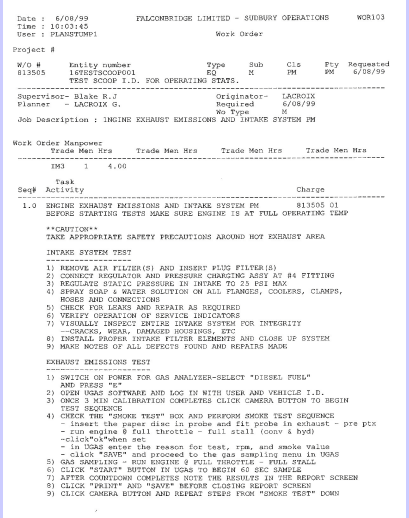
- ✔ Roles and Responsibilities
- ✔ Operational Issues
- ✔ Training
- ✔ Tools

- ✔ Maintenance Practices
- ✔ Process Detail
- ✔ Engine Subsystems
- ✔ Housekeeping and Organization

Auditing Engine Maintenance

Process Detail

PM and Recording Systems



Date : 6/08/99 FALCONBRIDGE LIMITED - SUDBURY OPERATIONS WOR103
Time : 10:03:45
User : PLANETUMP1 Work Order

Project #

W/O #	Entity number	Type	Sub	Cls	Pty	Requested
813505	16TEST5COOP001	EQ	N	PM	PM	6/08/99
	TEST SCOOP I.D. FOR OPERATING STATS.					

Supervisor- Blake R.J Originator- LACROIX
Planner - LACROIX G. Required 6/08/99
Wo Type M

Job Description : ENGINE EXHAUST EMISSIONS AND INTAKE SYSTEM PM

Work Order Manpower

Trade Men Hrs	Trade Men Hrs	Trade Men Hrs	Trade Men Hrs
IM3 1 4.00			

Seq#	Task Activity	Charge
1.0	ENGINE EXHAUST EMISSIONS AND INTAKE SYSTEM PM BEFORE STARTING TESTS MAKE SURE ENGINE IS AT FULL OPERATING TEMP	813505 01

CAUTION
TAKE APPROPRIATE SAFETY PRECAUTIONS AROUND HOT EXHAUST AREA

INTAKE SYSTEM TEST

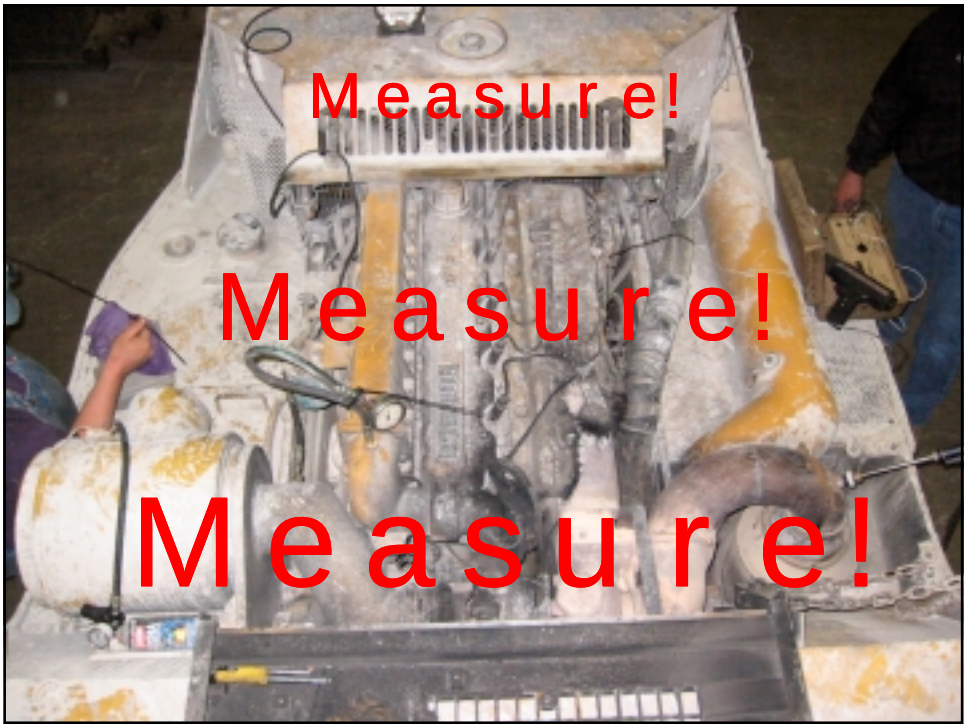
1) REMOVE AIR FILTER(S) AND INSERT PLUG FILTER(S)
2) CONNECT REGULATOR AND PRESSURE CHARGING ASSY AT #4 FITTING
3) REGULATE STATIC PRESSURE IN INTAKE TO 25 PSI MAX
4) SPRAY SOAP & WATER SOLUTION ON ALL FLANGES, COOLERS, CLAMPS, HOSES AND CONNECTIONS
5) CHECK FOR LEAKS AND REPAIR AS REQUIRED
6) VERIFY OPERATION OF SERVICE INDICATORS
7) VISUALLY INSPECT ENTIRE INTAKE SYSTEM FOR INTEGRITY
   --CRACKS, WEAR, DAMAGED HOUSINGS, ETC
8) INSTALL PROPER INTAKE FILTER ELEMENTS AND CLOSE UP SYSTEM
9) MAKE NOTES OF ALL DEFECTS FOUND AND REPAIRS MADE

EXHAUST EMISSIONS TEST

1) SWITCH ON POWER FOR GAS ANALYZER-SELECT "DIESEL FUEL" AND PRESS "E"
2) OPEN UGAS SOFTWARE AND LOG IN WITH USER AND VEHICLE I.D.
3) ONCE 3 MIN CALIBRATION COMPLETES CLICK CAMERA BUTTON TO BEGIN TEST SEQUENCE
4) CHECK THE "SMOKE TEST" BOX AND PERFORM SMOKE TEST SEQUENCE
   - insert the paper disc in probe and fit probe in exhaust - pre ptx
   - run engine @ full throttle - full stall (conv & hyd)
   -click"ok"when set
   - in UGAS enter the reason for test, rpm, and smoke value
   - click "SAVE" and proceed to the gas sampling menu in UGAS
5) GAS SAMPLING - RUN ENGINE @ FULL THROTTLE - FULL STALL
6) CLICK "START" BUTTON IN UGAS TO BEGIN 60 SEC SAMPLE
7) AFTER COUNTDOWN COMPLETES NOTE THE RESULTS IN THE REPORT SCREEN
8) CLICK "PRINT" AND "SAVE" BEFORE CLOSING REPORT SCREEN
9) CLICK CAMERA BUTTON AND REPEAT STEPS FROM "SMOKE TEST" DOWN

Auditing Engine Maintenance

Housekeeping



Intake Systems

Intake Systems

- Visual Inspection
- Check clamps and piping
- Don't overservice on replacement

- Measure Restriction
- Suction and Charge Sides

Intake Systems

TEST FOR INTEGRITY OF SYSTEM !!!

Exhaust Systems

Exhaust Systems

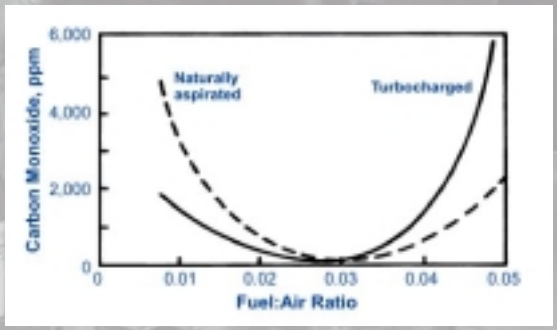
MEASURE

Exhaust Systems

UNDERSTAND

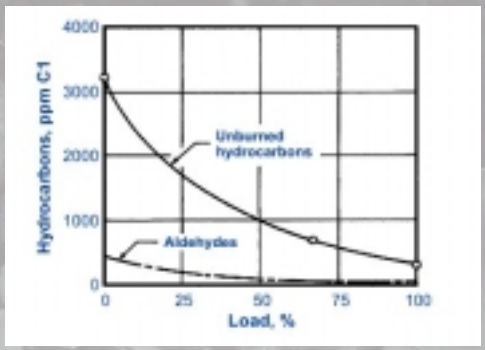
EMISSION	CAUSE	TYPICAL LEVEL IN UNTREATED EXHAUST	EFFECTS
Carbon Monoxide (CO)	Product of incomplete combustion of fuel. Usually problems with fuel system (injectors, pump, etc.) or plugged intake.	100 - 400 ppm	Lethal in large doses. Causes headaches and lethargy
Nitrogen Oxides (NOx)	Generated in the reaction between oxygen and nitrogen under high temperature and pressure in the engine cylinder. Usually problems with timing or valve settings.	650 ppm	Creates respiratory difficulties. Partly responsible for smog.
Sulfur Dioxide (SO2)	From sulfur content in fuel.	5 - 50 ppm	Partly responsible for acid rain.
Hydrocarbons (HC)	Unburned components of fuel. Could be derived from any of the conditions described above.	20 - 200 ppm	Responsible for harsh odor and eye / throat irritation.
Diesel Particulate Matter (DPM) Incl. Soluble Organic Fraction (SOF)	DPM is a product of incomplete combustion of fuel. Composed of the solid, visible particulate suspended in exhaust gas SOF: component of DPM hydrocarbons and their derivatives adsorbed on the surface on inorganic carbon (soot) particles. SOF may constitute 30% and more of the total DPM.	5 - 100 mg/m3	The black, blue and white smoke commonly seen in diesel exhaust. Commonly referred to as soot. Suspected to be a human carcinogen.

CO



- Air restriction
- Over fuelling
- Highly toxic
- Control: DOC
- **Levels: 100-400 ppm**

HC



- Hydrocarbons
- Source of eye and throat irritation
- Source: products on incomplete combustion
- Source: idling,unburned fuel,lube oil,etc
- Control: DOC
- Not field measurable (FID)
- Highly toxic
- **Levels: < 300 ppm**

Exhaust Systems

INSPECT & SERVICE

Exhaust Systems

INSPECT & SERVICE

Fuel & Injection Systems

Fuel & Injection Systems

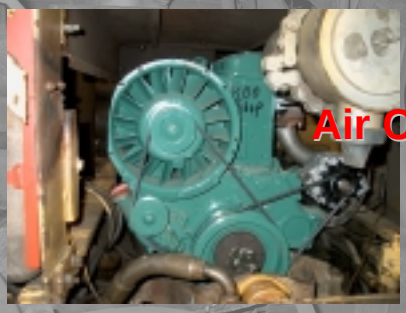
- Primary Fuel System (Transfer Pump)
- Filters
- Pressure
- Temperature

Fuel & Injection Systems

- Injectors / Pumps / Valves
- Air : Fuel
- Justified and Verified by ….
- MEASURED EMISSIONS !!!
- Trained & Qualified Mechanics

Cooling Systems

Cooling Systems



MYTH

Air Cooled ≠ Maintenance Free

Cooling Systems

Water Cooled Systems & Radiators

- ✔ Clean with 1” hose and degreaser
- ✔ Verify with ΔT measurement
- ✔ Pressure Test
- ✔ Coolant Mix & Additives
- ✔ Fan / Clutch / Belts
- ✔ Shutterstats & Aux Equip

Cooling Systems

PROBLEM	CAUSE
Low Coolant Level	❑ External leaks caused by loose / worn hoses, radiator cap, or defective relief valve ❑ Internal leaks caused be cracked cylinder head, cracked block, loose heads, damaged cooler core, damaged aftercooler, damaged gaskets
Reduced Air Flow Through Radiator	❑ Plugged radiator core ❑ Damaged or bent fins ❑ Low fan speed due to idle settings ❑ Fan damaged or incorrectly installed ❑ Loose fan belts, worn pulleys ❑ Damaged fan shroud, incorrect fan ❑ Incorrect fan blade / shroud position – 50% projection ❑ Excessive fan blade / shroud clearance – 0.38" max ❑ Closed shutters ❑ Fluid coupling or clutch not engaged
Low Cooling System Pressure	❑ External / internal leaks ❑ Defective radiator cap gasket ❑ Defective cooling system pressure relief valve ❑ Defective radiator top tank neck ❑ Defective pressure gauge
Coolant Overflow	❑ Air in cooling system due to incorrect system fill ❑ Combustion gases in cooling system ❑ Steam in system due to overload or low level
Insufficient Coolant Flow	❑ Stuck thermostat ❑ Absence of thermostat ❑ Low engine speed – High idle ❑ Loose or eroded water pump impeller ❑ Radiator plugged internally
High Intake Air Temperature or Restriction	❑ High ambient air temperature ❑ Plugged openings in screens for engine compartment with a blower fan ❑ Dirty aftercooler core ❑ Plugged air cleaner ❑ Damaged or carbon packed turbocharger
Low Heat Transfer	❑ Insufficient flow through heat exchanger ❑ Hot air for radiator due to overheating hydraulic oil cooler ❑ Scale on cylinder liners or cylinder head ❑ High ambient air temperatures with a marginally sized radiator
Exhaust Restriction	❑ Plugged air cleaner ❑ Damaged turbocharger ❑ Restriction in exhaust pipes ❑ Plugged aftertreatment device ❑ Excessive elbows, piping, etc.

Fuel Quality & Handling

Fuel Quality & Handling

- Storage Systems
- Verify and Follow Up
- Eliminate Contamination Sources

Fuel Quality & Handling

Ultimate Mine Diesel Fuel

QUALITY !!

- 500 ppm Sulfur max.
- 50 ppm Sulfur best

SULPHUR CONTENT - GUARANTEED < 50 ppm

SUPERIOR L-10 PERFORMANCE (PREMIUM ADDITIVE PACKAGE)

CETANE NUMBER - UNTIL EXPANSION & UPGRADE COMPLETE >43
- AFTER EXPANSION & UPGRADE COMPLETE >48

AROMATICS - WE WILL DETERMINE THROUGH TESTING AND PROVIDE ACTUAL LEVEL AS REQUIRED. THE AROMATIC LEVEL WILL BE LOWER THAN TYPICAL INDUSTRY LEVELS.

OTHERWISE MEET GENERAL STANDARDS BOARD (CGSB) TYPE "A" SPECIFICATIONS (90% POINT-</=290°C, FLASH->/=52°C, LUBRICITY- ETC.). PLEASE SEE CGSB TYPE "A" SPECIFICATION ATTACHED COMPLETE WITH THE ACTUAL PRODUCT SPECIFICATIONS.

Lubrication

Lubrication

- Lube Oil Grade: CH-4
- Filters: Quality vs Cost
- Oil Analysis Program
- Details: Oil Level

Training

- ✔ include operators & mechanics - select carefully
- ✔ small groups - 4 to 6 people
- ✔ balance of theory and practical
- ✔ graduated stages - focus on systems
- ✔ done by manufacturer reps and suppliers - technically qualified

Tools

Tools

Exhaust Emissions - UGAS

Tools

Intake Testing

Tools

Intake & Exhaust

⦸ Pressure / Restricti

Tools

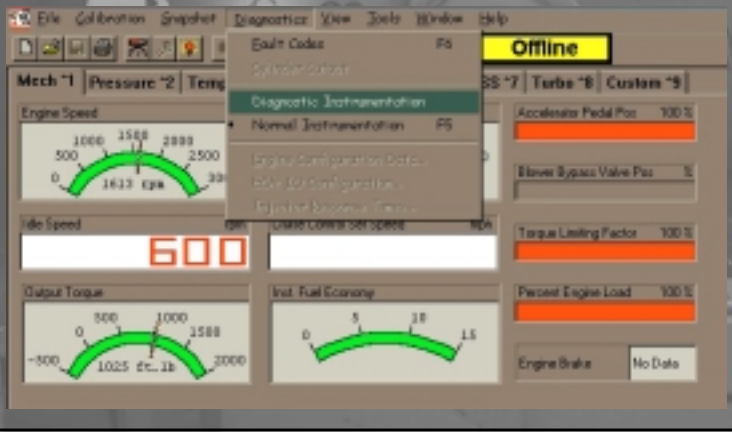
Cooling Systems

⦸ IR Temp Gun

Tools

Electronic Engines

- **Detroit Diesel Diagnostic Link**



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